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Indian Standard
SPECIFICATION FOR
DC GENERATORS FOR AIRCRAFT

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SPECIFICATION FOR DC GENERATORS FOR AIRCRAFT

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(Continued on page 2)

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Indian Standard

SPECIFICATION FOR DC GENERATORS FOR AIRCRAFT

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 18 May 1979, after the draft finalized by the Aircraft Electrical Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 DC generators intended for use in aircrafts which are subject to civil or military airworthiness requirements of India shall be subject to inspection and any directives issued from time to time by such statutory authorities.

0.3 This standard is based on BS 2G 134 Specification for dc generators, issued by the British Standards Institution.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers generators for dc power supply for aircrafts.

2. DESIGN AND CONSTRUCTION

2.1 The design and construction of the generators shall comply with IS : 8946-1978†.

2.2 The design aim should be to achieve 3 000 (aircraft) hours operation of the machine before maintenance is necessary.

3. VOLTAGE

3.1 The terminal voltage shall be in accordance with IS : 7854-1975‡.

*Rules for rounding off numerical values (*revised*).

†General requirements for rotating electrical machinery for aircraft.

‡Voltages and frequency for aircraft electrical systems.

4. COOLING AND MOUNTING ARRANGEMENTS

4.1 The arrangements for cooling, mounting and drive shall be as agreed to between the manufacturer and the purchaser.

5. ELECTRICAL CONNECTION

5.1 Terminals shall be provided for both positive and negative leads and also for the open end of the excitation winding and other connections.

5.2 Provision shall be made in the terminal box for effecting changes in the direction of rotation, when necessary. Clear and permanent indications of correct connections for each direction of rotation shall be given in the terminal box.

5.3 Provision shall be made for internal radio interference suppression in the generator or attachments suitable for screened cable connections provided in the generator. Any winding connected in series with the armature shall preferably be disposed symmetrically in the armature circuit.

NOTE—Detailed requirements regarding acceptable limits are under consideration.

5.4 The excitation system shall be independent of any external electrical supply and shall be capable of initial build up without reference to any other supply. Supplementary excitation may be employed only by agreement between the manufacturer and the user.

6. PERFORMANCE, RATING AND OVERLOAD REQUIREMENTS

6.1 The continuous rated output of the generator under declared conditions of speed, altitude and cooling shall be declared by the manufacturer in the form specified in IS : 7855-1975*. Power required to drive the generator under overload conditions and the polar moment of inertia of the generator shall also be indicated in the form.

6.2 The generator shall be capable of the following normal rated load operation at steady-temperature conditions:

- a) Maintaining 125 percent rated-load current at rated voltage and 125 percent of minimum speed for a period of 5 minutes.
- b) Generating 200 percent of rated current for at least 5 seconds.

6.3 Consideration shall be given to the highest speed at which the generator could be driven for its intended applications if the overspeed protection devices fail. If this speed is more than 120 percent of the maximum rated speed, the generator shall be designed either to withstand

*Form for declaration of performance of aircraft electrical equipment.

the higher speed or to fail at a lower speed of not less than 120 percent of the maximum rated speed and to contain all its parts within the machine frame after failure, without detriment to its mounting. The containment requirements and the necessary proving tests shall be as agreed to between the manufacturer and the user.

7. ENVIRONMENTAL CONDITIONS

7.1 The generator shall comply with the following requirements:

- a) Vibration to IS : 8252 (Part XIV)- *.
- b) Acceleration to IS : 8252 (Part XV)- †.
- c) Temperature pressure to IS : 8252 (Part II)-1979‡.
- d) Radio interference suppression to IS : 8252 (Part XIX)- §.
- e) Compass safe distance to IS : 8252 (Part XVIII)- ||.

8. MARKING

8.1 A name plate bearing the part number and serial number of the generator shall be mounted on the body of the generator.

8.2 The following information shall be marked on the name plate:

- a) Number of this Indian Standard,
- b) Manufacturer's part No.,
- c) Serial number of the generator,
- d) Rated voltage,
- e) Rated current,
- f) Normal direction of rotation, and
- g) Year of manufacture.

9. TESTS

9.1 Test Condition — Unless otherwise specified the tests shall be carried out at normal temperature and test conditions as specified in IS : 196-1966¶.

*Environmental tests for aircraft equipment: Part XIV Vibration (*under preparation*).

†Environmental tests for aircraft equipment: Part XV Constant acceleration (*under preparation*).

‡Environmental tests for aircraft equipment: Part II Temperature pressure and humidity.

§Environmental tests for aircraft equipment: Part XIX Radio interference (*under preparation*).

||Environmental tests for aircraft equipment: Part XVIII Magnetic influence (*under preparation*).

¶Atmospheric conditions for testing (*revised*).

9.2 Tests shall be made to check compliance with all the requirements of this standard. They shall be of two categories:

a) *Type Tests* — These are tests to establish whether a particular type or design of the equipment meets the requirements of this standard. They shall be carried out on one or more generators of the type, as agreed to between the supplier and the testing authority. The following shall constitute the type tests:

- 1) Preliminary inspection/preparation for test (**9.3.1**),
- 2) Cold resistance test (**9.3.2**),
- 3) Commutation (**9.3.3**),
- 4) Ripple voltage (**9.3.4**),
- 5) Magnetisation characteristics (**9.3.5**),
- 6) Temperature test (**9.3.6**),
- 7) Overload checks (**9.3.7**),
- 8) Temperature (shortened standard test) (**9.3.8**),
- 9) Insulation resistance (**9.3.9**),
- 10) Overspeed test (**9.3.10**),
- 11) Test for rating (**9.3.11**),
- 12) Brush performance at altitude (**9.3.12**),
- 13) Endurance and overload tests (**9.3.13**),
- 14) Vibration (**9.3.14**),
- 15) Acceleration (**9.3.15**),
- 16) Temperature-pressure tests (**9.3.16**),
- 17) Compass interference (**9.3.17**),
- 18) Resistance to environmental contamination (**9.3.18**), and
- 19) High voltage test (**9.3.19**).

b) *Routine Tests* — These shall be carried out on all generators manufactured in conformity with this standard. The following shall constitute the routine tests:

- 1) Component check (**9.4.1**),
- 2) Resistance of windings (**9.4.2**),
- 3) Brush bedding and adjustment (**9.4.3**),
- 4) Temperature test (on commutator machines only) (**9.4.4**),
- 5) Overspeed test (**9.4.5**),

- 6) Loading test (9.4.6),
- 7) Insulation check (9.4.7),
- 8) Duration of high voltage test (9.4.8),
- 9) Temperature test (9.4.9),
- 10) Environmental tests (9.4.10), and
- 11) Endurance tests (9.4.11).

NOTE — Wherever relevant, the characteristics, or values actually measured, shall not deviate by more than 10 percent from the declared values or the observation made during various tests listed above.

9.3 Type Tests

9.3.1 Preliminary Inspection/Preparation for Test — The principal components of the generator shall be dimensionally checked against the relevant drawings and a record made of the parts liable to wear. A check shall be made to ensure that the brushes are bedded over the full arc for at least 80 percent of their axial width. Any running required to conditions the commutator surface shall be done prior to the commencement of the tests. The weight of the generator, the distance of its centre of gravity from the mounting flange, and the polar moment of inertia of the rotor shall be determined. Checks to ensure conformity with requirements specified in IS : 8946-1978* shall be made.

9.3.2 Cold Resistance Test — The cold resistance of all the windings shall be measured at room temperature, corrected to a standard temperature of 27°C (see IS : 196-1966†) and checked for conformity with the declared value.

9.3.3 Commutation — The commutation of the generator shall be measured under extreme conditions of load and speed (that is at maximum speed under rated load and no load).

9.3.4 Ripple Voltage — The ripple voltage shall not exceed 4.5 V peak to peak at the generator terminals when the generator is supplying rated-load current to a non-inductive resistive load after due account is taken of effect of feeder cables on ripple current.

9.3.5 Magnetisation Characteristics

9.3.5.1 Open-circuit characteristics — With the speed maintained constant at minimum rated speed, a curve showing the relation between open-circuit voltage and varying field current shall be plotted.

*General requirements for rotating electrical machinery for aircraft.

†Atmospheric conditions for testing (revised).

9.3.5.2 Load excitation characteristics — A family of curves showing the variation of excitation current and driving torque with speed, throughout the speed range of the generator, at its rated voltage shall be plotted for values of load current from no load to 125 percent of its rated load.

9.3.6 Temperature Test — Temperature test shall be carried out at rated minimum and maximum speeds at ground level conditions. During these runs, the load current shall be maintained at rated full load value and the voltage shall be maintained at its rated value by field control. During the test, the generator shall have all the covers that are normally fitted and the rated quantity of coolant shall pass through the generator. These runs shall be continued for a period of one hour after steady temperature conditions have been reached. Records of output voltage and current, excitation current and voltage, speed, quality of commutation, coolant temperature, ambient temperature and winding temperatures shall be maintained during the test.

9.3.7 Overload Checks — Following the test in 9.3.6, additional tests to check compliance with the provisions of the overload requirements as given in 6.2 shall be made.

9.3.8 Temperature (Shortened Standard Test) — For standardizing a test for subsequent production machines, the generator shall be run from cold, without coolant for a period of 10 minutes at a minimum speed, with load adjusted to produce a final temperature in the critical components within 5°C of that recorded in the corresponding test specified in 9.3.6, care being taken to ensure adequate lubrication of the bearings. An average value of this load shall be recorded.

9.3.9 Insulation Resistance — While the windings are still hot from the test in 9.3.8, the generator shall be subjected to an insulation resistance test. This resistance shall not be less than $2 \text{ M}\Omega$ when measured at 250 V dc and with suppression capacitors disconnected.

9.3.10 Overspeed Test — Immediately after the test in 9.3.9, and while still hot, the generator shall be run for 3 minutes at 120 percent of its maximum rated speed or at such higher speed as may be agreed upon between the manufacturer and the user. The generator shall be stripped and examined, and there shall be no signs of relative movement of the rotating parts, nor damage to the stator or rotor. The balance of the rotor shall also be checked. The generator shall be tested where necessary to check compliance with the requirements for containment referred to in 6.3.

9.3.11 Test for Rating — A series of tests shall be made to check the declared ratings referred to in 6.1. During the tests, the following data shall be recorded:

- a) Output voltage and current;

- b) Excitation current and voltage;
- c) Speed;
- d) Quality of commutation;
- e) Mass flow rate, inlet and outlet temperatures and inlet and outlet pressures of coolant; and
- f) Other relevant temperatures including ambient temperature and winding temperatures.

9.3.12 Brush Performance at Altitude — These tests are applicable only to generators having brushes and with commutators, and are intended primarily to check brush performance.

9.3.12.1 The tests shall be carried out in an altitude chamber with the temperature, pressure and humidity maintained at the values normally prevailing at the maximum rated altitude of the generator under International Standard Atmosphere (ISA) conditions. Tests shall be carried out at 90 percent of maximum speed with the coolant flow appropriate to the altitude conditions.

9.3.12.2 The generator shall be run at rated load for 100 hours in twenty cycles of 5 hours duration, each cycle being preceded by one hour ground level run.

9.3.12.3 The generator shall be run on no load at rated voltage for 10 hours at ground level followed by 10 hours at the maximum altitude rating of the generator. If glazing occurs under these conditions, the minimum load to prevent glazing shall be determined and declared.

9.3.12.4 For aircooled generator the records of the following data shall be maintained:

- a) Terminal voltage;
- b) Load-current;
- c) Air pressure drop across the generator;
- d) Mass flow of air;
- e) Outlet air pressure;
- f) Inlet air temperature;
- g) Inlet dew point;
- h) Temperature of the hottest brush taken at intervals of not more than one hour, measured by a thermocouple embedded in brush;
- j) Initial length of each brush; and
- k) The length of each brush at the end of each run.

9.3.13 Endurance and Overload Tests

9.3.13.1 Prior to the commencement of this test, dimensions of parts liable to wear shall be measured and the ambient temperature noted. No maintenance or major adjustments of any kind shall be performed on the generator during this test, except that new brushes may be fitted, if necessary. The time taken to bed new brushes shall not constitute a part of the test. A record shall be kept of the wear of the brushes.

9.3.13.2 The generator shall be run at 90 percent of maximum speed under rated cooling conditions for 1 000 hours, in cycles of 6 to 20 hours duration, with sufficient shut down temperature between cycles to allow the generator to cool to room temperature. For the first 100 hours of the test, the generator shall be run at rated-load, except that during the last cycle, and not less than 5 hours before the end of the last cycle, an overload test shall be made under the conditions specified in 6.2(a). At the end of this cycle, the generator shall be tested for compliance with 6.2(b). For the remainder of the test, the load may be reduced to 75 percent of rated load under standard environmental conditions.

9.3.13.3 At the conclusion of the tests given in 9.3.13.1 and 9.3.13.2 the generator shall be tested at minimum, average and maximum speeds in respect of freedom from radio interference.

9.3.13.4 At the end of the test in 9.3.13.3, the insulation resistance measured at 250 V dc, shall not be less than 100 k Ω . The generator shall be cleaned, without replacement of any part, after which the insulation resistance shall not be less than 1 M Ω . Failure to attain this value shall be investigated and a record made of any necessary action to achieve this.

9.3.13.5 Finally, the generator shall be stripped and examined for any unusual wear and obvious visual defects of the components.

9.3.14 Vibration — The generator shall function satisfactorily when subjected to vibrations of the appropriate grade declared by the manufacturer as specified in IS : 8252 (Part XIV) - *.

9.3.15 Acceleration — The generator shall function satisfactorily when subjected to the acceleration test of the appropriate grade declared by the manufacturer as specified in IS : 8252 (Part XV) - †.

9.3.16 Temperature-Pressure Tests

*Environmental tests for aircraft equipment : Part XIV Vibration (*under preparation*).

†Environmental tests for aircraft equipment : Part XV Constant acceleration (*under preparation*).

9.3.16.1 The generator shall function satisfactorily when subjected to pressure/temperature appropriate to the classification grading declared by the manufacturer in accordance with IS : 8252 (Part II)-1979*.

9.3.16.2 During the functioning tests for the appropriate category, the generator shall be run at average speed for a few minutes to ensure that all moving parts and brushes are free. It is acceptable for the generator to be run as a motor and the input power recorded. For the low temperature functioning tests, the temperature of the chamber may be lowered so that the generator is at its minimum declared ambient temperature.

9.3.16.3 Insulation resistance shall be measured before the tests required in **9.3.16.2** and also immediately on removal from the chamber after these tests and at suitable intervals of time to enable the recovery under normal ambient temperature conditions to be plotted over a period of 24 hours.

9.3.17 *Compass Interference* — The generator shall be subjected to the tests for compass safe-distance, in accordance with IS : 8252 (Part XVIII)- †.

9.3.18 *Resistance to Environmental Contamination*

9.3.18.1 *Waterproofness* — The generator shall comply with the requirements of IS : 8252 (Part VI)-1976‡.

9.3.18.2 *Salt corrosion* — The generator shall comply with the requirements of IS : 8252 (Part X)-1979§.

9.3.18.3 *Dust and sand* — The generator shall comply with the requirements of IS : 8252 (Part VII)- ‖.

9.3.18.4 *Fluid contamination* — The generator shall comply with the requirements of IS : 8252 (Part XXII)- ¶.

9.3.18.5 At the conclusion of each test, the generator shall be examined for signs of deterioration, such as softening of paints and varnishes. After the final test, it shall be checked for normal functioning.

*Environmental tests for aircraft equipment : Part II Temperature, pressure and humidity.

†Environmental tests for aircraft equipment : Part XVIII Magnetic influence (*under preparation*).

‡Environmental tests for aircraft equipment : Part VI Waterproofness.

§Environmental tests for aircraft equipment : Part X Salt mist.

||Environmental tests for aircraft equipment : Part VII Sand and dust (*under preparation*).

¶Environmental tests for aircraft equipment : Part XXII Fluid contamination (*under preparation*).

9.3.19 *High Voltage Test*

9.3.19.1 A test voltage of 500 volts dc shall be applied between the windings and the frame of the generator, with core connected to the frame and, the windings not under test. The test voltage shall be applied once only to a new and completed motor in normal working condition with all its parts in place.

9.3.19.2 It is generally advisable that the high voltage test should not be applied if insulation resistance is less than that specified in the relevant equipment specification.

9.3.19.3 *Duration of high voltage test* — The test shall be conducted at a voltage of about one-third of the test voltage which shall be increased to the full test voltage, as rapidly as is consistent with its being indicated by the measuring instrument. The full test voltage shall be maintained for one minute. At the end of this period, the test voltage shall be rapidly diminished to one-third of its full value before switching off.

9.4 Routine Tests

9.4.1 *Component Check* — All components and sub-assemblies of each generator shall be checked for workmanship and for conformity to approved drawings.

9.4.2 *Resistance of Windings* — The resistance of all windings, measured at room temperature and corrected to standard temperature shall be within 10 percent of the declared value.

9.4.3 *Brush Bedding and Adjustment* — Generators fitted with brushes shall be run at a suitable speed for a period sufficient to ensure that the brushes are bedded over the full arc for at least 80 percent of their axial width. Where applicable, the brush-position shall be adjusted and the setting indicated by a suitable marking. After setting, the generator shall be run for sufficient time to ensure that the brushes are correctly bedded. Any running required to condition the commutator surface shall also be done at this stage.

9.4.4 *Temperature Test (on Commutator Machines Only)* — A test of 10 minute duration shall be carried out at rated minimum speed without cooling. The load shall be that determined in the shortened standard test for temperature for type test specified in 9.3.8 and the excitation of the generator shall be varied to maintain rated output voltage. At the end of this test, the temperature rise of the commutator and of the shunt field winding shall not exceed 110 percent of the declared temperature rise under normal conditions.

9.4.5 Overspeed Test — While the generator is still hot from the test in 9.4.4, it shall be run for at least one minute at 120 percent of its rated maximum speed. There shall be no excessive noise or vibration during the run.

9.4.6 Loading Test — While the generator is still hot from the test in 9.4.5, the excitation required to produce rated voltage on no-load and rated load, at rated maximum and minimum speeds, in that order, shall be determined. The values obtained shall be within the declared limits. The quality of commutation shall be satisfactory. A check shall also be made to confirm if the polarity of the terminals is correct.

9.4.7 Insulation Check — While the generator is still hot from the test in 9.4.6, and with the capacitor disconnected, the insulation resistance between live parts and the frame, measured at 250 V dc, shall not be less than 2 megohms.

9.4.8 Duration of High Voltage Test — The high voltage test shall be conducted as in 9.3.19. A test voltage equal to the specified one shall be applied between the windings and the frame, with the core connected to the frame and the windings not under test for 5 seconds.

9.4.9 Temperature Test — This shall be carried out on representative samples from production batches in a manner similar to the test specified in 9.3.6.

9.4.10 Environmental Tests — These tests shall be carried out on representative samples from production batches to check compliance with 7.

9.4.11 Endurance Tests — These tests shall be carried out on representative samples from production batches, and shall be carried out as per procedure specified in 9.3.13 except that the duration of the test on production batches may be reduced to 200 hours.

9.5 Number of Samples for Type Tests and Criterion for Conformity — The number of samples to be tested for type tests and during production tests shall be as specified by the type-approving authority. If a sample fails during any of the tests, it shall be closely inspected and dismantled, and if necessary, a report on the probable cause of failure shall be made to the approving authority. With the approval of the approving authority, the test may be repeated on not more than one additional sample during type test and not more than two additional samples from each production batch, before a final decision on acceptance/rejection is taken.

INDIAN STANDARDS

ON

AIRCRAFT ELECTRICAL EQUIPMENT

IS :

- 2032 (Part XV)-1976 Graphical symbols used in electrotechnology : Part XV Aircraft electrical symbols
- 7854-1975 Voltages and frequency for aircraft electrical systems
- 7855-1975 Form of declaration of performance of aircraft electrical equipment
- 7856-1975 Safety features for ground power units for direct current aircraft servicing and engine starting
- 7857-1975 Aircraft-fuel nozzle grounding plugs and sockets
- 7915-1976 Dimensions for connections for aircraft ground electrical supplies
- 8252 (Part XVIII)-1978 Environmental tests for aircraft equipment : Part XVIII Magnetic influence
- 8705-1978 Static invertors for aircraft
- 8706-1978 Safety features for ground power units for alternating current aircraft servicing
- 8834-1978 Dimensions for general purpose push-pull three-pole circuit breakers for aircraft
- 8852-1978 Dimensions for general purpose push-pull single-pole circuit-breakers for aircraft
- 8946-1978 General requirements for rotating electrical machinery for aircraft
- 8980-1978 General purpose push-pull single-pole circuit breakers for aircraft
- 8981-1978 Extra low voltage and low voltage spring return non-latch switches for aircraft